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Ultrafast dynamics of mobile charges and excitons in hybrid lead halide perovskites

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In this talk we discuss recent experiments using ultra-broadband time-resolved THz spectroscopy (uTRTS) studying charge and excitonic degrees of freedom in the novel photovoltaic material CH3NH3PbI3. This technique uses near single-cycle and phase stable bursts of light with an ultra-broad bandwidth spanning 1 - 125 meV to take snapshots of a material's dielectric function or optical conductivity on femtosecond time scales after photoexcitation. These transient spectra reveal free charge transport properties on unprecedented time scales, and at the same time can probe internal excitations of Coulombically bound excitons. It is therefore an ideal technique for studying materials related to solar energy conversion such as semiconducting polymers, quantum dots and even the new hybrid metal halide perovskites. We apply uTRTS to a single crystal of CH3NH3PbI3, temporally resolving the charge carrier generation dynamics, the screening of infrared active phonons and the dissociation of excitons. Our measurements reveal remarkably high charge carrier mobilities on ultrafast time scales, as well as the importance of screening at elevated carrier densities.

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